REPRINT FROM THE BRITISH JOURNAL OF PHYSICAL MEDICINE ( APRIL, 1938)

Electrotherapy Papers No. 8

# THE FARADIC CURRENT: TECHNIQUE, APPLICATION AND CLINICAL INDICATIONS

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The faradic current is the type of low-voltage varying currents. It is a low-voltage current because the difference of potential between electrodes when applied to the body is relatively slight and does not allow of more than a few milliamperes to pass through the body. It is varying because its strength changes rhythmically either from maximum to zero or between maximum and minimum. All low-voltage varying currents possess the power to stimulate the excitable tissues.

## PHYSIOLOGICAL PROPERTIES OF THE FARADIC CURRENT

The faradic current possesses three important physiological properties, namely, (1) stimulation of muscular contractions and thus of muscular metabolism, (2) reflex stimulation, via the skin, of the vegetative nervous system and endocrines, and (3) psychological effects.

(1) The most striking result of the stimulating action of the faradic and all low-voltage varying currents refers to the muscles. As was seen in a preceding paper, the faradic current stimulates contraction of the muscles by stimulating their motor nerves. When a muscle is stimulated and contracts a series of metabolic processes occur; these are the normal metabolic processes of muscles. Thus the muscle is exercised. Not only are these metabolic processes initiated but the circulation of the muscle improves. During the contraction, blood is expelled from the veins, and when the muscle relaxes blood flows into the arteries, regurgitation from the veins being prevented by means of their valves. D'Arsonval has shown that, during the production of muscular contraction by the faradic current, the respiratory exchanges of the muscle are increased, and that, even if the current is insufficient to cause any muscular contraction, an increase in respiratory exchange is observed. He has also shown that this phenomenon occurs with the faradic current, and probably more intensely wih the sinusoidal alternating current, but that the constant galvanic current does not affect the respiratory exchanges.

As has been seen, stimulation of muscle metabolism is determined by direct stimulation of the motor nerves of the muscles, but this stimulation can occur also by a reflex mechanism. The skin is stimulated. The stimulus departing from the skin reaches the posterior horn of the spinal medulla, via the sensory nerves, and thence can, by transmitting itself to the anterior horn, be transformed into a motor impulse and thus determine reflexly a muscular contraction. Even if muscular contraction is not determined the metabolism of the muscle is stimulated.

(2) Stimulation of the muscle is one effect of the faradic current and stimulation of the skin another; both of them have far-reaching consequences. While one result of skin stimulation is the reflex stimulation of muscle contraction and muscle metabolism, by far the most important effect is probably an action on the endocrine glands. Renton Elliott has shown that the output of the suprarenal gland

can be increased by stimulating the afferent nerves, and although clinically this is not distinctly seen, it can be demonstrated with faradic currents acting on a larger surface of the skin, with the static effluve, for instance, which causes the blood pressure to rise. Through this mechanism the faradic current appears as a powerful agent of reflexotherapy. The mechanism of reflexotherapy has already been described. It consists in the initiation of reflexes on the skin, which reach deeply into the body and have far-reaching effects.

(3) Another phase of the action of the faradic current is the physical effect. Sixty or seventy years ago the consulting-room of Duchenne, a general practitioner of Boulogne who had become famous through his work on the faradic current, was thronged by people who came to have faradic current for various ills of the nervous system. This action was probably mainly of psychical nature. In my student days I often saw the famous neurologist, Babinski, demonstrate to his classes the powerful psychological effects of the faradic current. He used to treat individuals, with tabes and severe ataxic phenomena, who could scarcely walk. After applying certain faradic stimulations he showed that they could walk better. During the War a pupil of Babinski, Clovis Vincent, carried the method rather too far by means of intense faradic stimulation, which he called torpillage. Although the method was rather exaggerated and dangerous, its powerful reflexotherapy, combined with the strong psychological effects, gave good results. Many may object that we cannot ascribe to the faradic current effects which belong to psychotherapy. The argument, however, is fallacious. Psychotherapy is undoubtedly a potent therapeutic method, probably the most powerful that we possess. But psychotherapy cannot be effected through words only. There are various methods of applying psychotherapy, and one of them is undeniably the application of physical procedures.

Thus the faradic current has three definite properties which can be utilized in clinical practice: (a) the power to stimulate muscles and initiate normal muscle metabolism; (b) the power to stimulate the skin and initiate therapeutic reflex action; (c) the power to produce psychological effects.

## COMBINATION OF FARADIC CURRENT AND OTHER METHODS

Study of the faradic current and its therapeutic application should be made in conjunction with other procedures of similar physiological and therapeutic value, particularly the application of active and passive movements and massage.

This is necessary not only for complete therapeutic effects but also for an understanding of the action of the faradic current. Ultra-specialization and a narrow conception of physical procedures have hampered their utilization in general practice. It should be remembered that, in physical medicine, we have two series of procedures -- non-instrumental and instrumental. Non-instrumental physical methods utilize the virgin forces of Nature -- sun, movement, air, waters, and climates. Instrumental physical methods are the various electrotherapeutic and actinotherapeutic procedures described in this series of papers. Instrumental methods can be thoroughly understood only by those who have studied non-instrumental physical medicine, the natural cure throughout the ages. Just as the mechanism of ultra-violet irradiation can be understood and thus rationally applied only by those who have studied the effects of sun irradiation, the faradic current can be understood and rationally applied only by those who understand the mechanism of action of exercise, passive movements and massage. As James Mackenzie pointed out, the procedures of instrumental clinical investigation (electrocardio-

graphy, sphygmography, and so on) have helped clinicians to understand and apply more rationally the procedures of non-instrumental clinical investigation (auscultation, percussion and inspection). In the same manner the procedures of instrumental physical medicine have helped us to a better application of the non-instrumental methods of physical medicine.

Mennell has written admirably on the abuse of faradic current and many clinicians will concur with the opinions expressed by this author. The faradic current is abused because those who apply it do not apply it in conjunction with exercise, passive movement and massage, which procedures have a similar action on muscle metabolism. One of the definite results of the general practitioner who adds the faradic current to his physical armamentarium is a more rational use of passive movement, exercise and massage. These methods have the same action on muscular physiology as the faradic current. They stimulate and initiate the normal processes of muscular metabolism.

## CHOICE OF APPARATUS

For practical purposes a faradic apparatus, on the model of the Bristow coil, is sufficient. It has the advantage of being portable, and the simple device of an iron cord winding in and out of the primary coil allows flexible regulation of the intensity of the secondary current. There has been great progress in faradic apparatus, and it is probable that the newly introduced vacuum-tube type of Wade generator will prove a more effective system.

There are two important points to consider, namely, modification of current intensity, and devices for interrupting the current. Currents which are interrupted more than once or twice a second should not be passed through the body just as they are, even if they are well tolerated by the patient. The muscles on the path of such currents remain in a state of clonic or tonic contraction, because the periods of rest between the stimuli are too short. Prolonged contraction without rest soon fatigues the muscles and is very harmful. It should be remembered that, even if no actual contraction of the muscle occurs, there should be periods of rest between stimulations. Although between each period of flow of the faradic current there is a period of rest, it is far too short to allow the muscles to relax before the next stimulation. It is important, therefore, to use a device which allows the muscles to relax and rest before subsequent stimulation.

The interrupting key is often helpful in individual muscle stimulation. The metronome interrupter may be used for the same purpose. Another method of ensuring adequate periods of rest is to cause the current to surge. A faradic current is said to surge when the strength attained during each period of flow gradually increases to a maximum and then gradually decreases to zero. There exist various devices for making the current surge.

On the whole, as in most procedures of physical medicine, standard measures are of no avail, and much depends on the individual examination of the reactions of the patient. Pain, fatigue and other symptoms indicate whether contractions are too near each other or too widely spaced.

## GENERAL TECHNIQUE OF APPLICATION

The faradic current for stimulation of muscles may be carried out, either in the form of individual stimulation of muscles or of simultaneous treatment of a group

of muscles. A combination of the two procedures is often advisable.

In individual stimulation of muscles each muscle receives at its point of election of stimulation a faradic current of just enough strength to bring about contraction. It is often sufficient, particularly for very weak muscles, to elicit a palpable but not necessarily visible contraction.

The patient is placed in a comfortable position, the parts to be treated are well supported and relaxed. They are first warmed by infra-red rays. The inactive or dispersing electrode, which should be fairly large (at least 3 x 4") is placed upon a part of the body where there are no muscles (the sternum, the spine) or in some cases it can be held in the hand. The active electrode (1" in dia., preferably with an interrupting key) is placed on the point of election of stimulation, that is, either on the middle of the muscle belly or on the point indicated on the chart for stimulation of the motor nerve. With alittle practice the physician can become an expert at locating quickly the best point of stimulation of each muscle. The amount of current should be as low as possible at first. It should be remembered that a certain amount of skin resistance has to be overcome, and therefore the same strength of current may not elicit a contraction at first but may cause a strong, even painful, contraction a few minutes afterwards. Thus if the intensity of the current is increased rapidly the patient feels pain. When the muscular contraction has been produced, a certain time must be allowed for relaxation. Too frequent contractions must be avoided in all cases. If a muscular contraction is obtained without pain to the patient, and is followed by a certain degree of relaxation, the intensity of the current is increased and a stronger contraction obtained. After a short time, the current may be increased again. The number of contractions depends entirely on the degree of weakness and the type of response. The time of relaxation, therefore, varies for each patient.

This method of treatment is essentially individual, and all mechanical devices which progressively cause increase in the contractions should be eschewed. Individual attention is important and for that reason the physician himself must apply the faradic current.

Careful watch must be kept for signs of over-stimulation. These vary. One of the most important is the subjective feeling of the patient. He may experience pain, fatigue, malaise. Objective signs are a slowing of the rate of contraction and relaxation, and marked tremor during contraction. Several hours after treatment the patient may feel stiffness or pain instead of the usual prolonged feeling of comfort. This means that there has been over-stimulation.

Individual muscle stimulation is the ideal method of treating any form of muscular weakness and paralysis. It must be based on a thorough clinical understanding of the patient, and must often be combined with other procedures (infra-red irradiation, massage, passive and active movements).

In group stimulation two electrodes, as a rule of equal size, are applied to the opposite ends of an extremity. For example, one electrode may be applied to the sole of the foot, the other under the buttocks, or under the sole of the other foot. For the upper extremity one electrode is held in the hand and the other is applied to the interscapular space.

The patient is placed comfortably, the current is started gradually, and careful observation is made of the alternation of contraction and relaxation, as for the individual method of muscle stimulation.

Group stimulation, when the muscles are in fairly good condition, can last for 5 to 10 minutes. It can be repeated every day or every other day according to the clinical condition. It is a good method for use when an entire extremity or a large group of muscles needs treatment, but on the whole it is greatly inferior to individual muscle stimulation. The Bergonie method of treatment of obesity is a special mode of the faradic treatment of group muscle stimulation.

The general dosage of faradic current application can be divided into (a) minimal, (b) mild, (c) strong.

In the minimal application intensity is very low and the intervals between faradic stimulation are very long. This is the procedure to use when it is desired principally to produce metabolic effects and when the muscles tire easily.

In the mild application a palpable contraction of the muscle is elicited, or a slightly painful reaction of the skin. Intervals between stimulations are shorter than in minimal applications. This is the usual dosage.

In strong applications visible contractions or intense stimulation of the sensory nerves of the skin are elicited. Intervals between stimulations are short. This is the dosage with which reflexotherapeutic and psychotherapeutic effects are obtained.

The above considerations are on general lines only, since individualization is the rule in application of the faradic current.

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## FARADIC CURRENT IN DISEASES OF THE JOINTS

One of the most frequent applications of faradic current in general practice is in the treatment of muscular weakness in certain diseases of the joints, such as chronic rheumatic conditions and traumatic or infective arthritis. In all these conditions the muscles are atrophied, either because of a reflex action from the joint lesion or through disuse.

When the physician has to treat such a condition he must remember first of all that the most important therapeutic methods are massage and exercise. In most cases faradic current is a valuable addition, but should be only an addition to treatment by massage and exercise. Yet in many conditions in which the natural muscle function is lost, artificial stimulation leads to improvement of muscle metabolism and encourages voluntary efforts on the part of the patient. In diseases of the joints the muscles are simply weak, and electrical investigation shows no signs of the reaction of degeneration. Such muscles respond well to a succession of very short stimulations, sufficiently surged and spaced to allow of gradual contraction and an adequate period of relaxation. The individual method of stimulation should be used in preference to others, especially, as with this method, massage and exercise can be better combined.

Morton Smart has done much to develop the principles of graduated muscular stimulation, which is utilized in diseases of the joints. This author says that the object of faradic stimulation is not only to restore tone to injured muscles but also to prevent inter- and intra-muscular adhesions, to keep the tendons and other parts mobile so that they do not become adherent to contiguous structures, and above all generally to increase the blood supply to the injured tissues and to

stimulate the rate of repair by promoting the absorption of waste products.

Faradic current must be applied only to carefully selected patients.

## FARADIC CURRENT IN PERIPHERAL NEURITIS WITH PARALYSIS OF THE MUSCLES

In such conditions the faradic current is very valuable. Its method of application here is delicate, and demands first of all a certain amount of neurological knowledge. It is to be hoped that, in days to come, neurologists will themselves apply physical methods in the treatment of their patients.

It is important here to avoid fatigue, and the treatment, therefore, needs great care. The following is a general plan:

(1) When the patient comes for treatment with a peripheral neuritis with muscular paralysis, the muscles should be tested for electrical reactions. If the test shows, perhaps, slight modifications but not a real reaction of degeneration, the first treatment to be applied is infra-red irradiation, massage and constant galvanic current for its trophic effect. Diathermy is also very valuable. If at that period the muscles show a reaction of degeneration the same treatment should be employed, but as soon as possible the interrupted galvanic current, the sinusoidal current or the Lapicque current is started.

(2) In cases of peripheral neuritis with paralytic phenomena in which there is no reaction of degeneration, the faradic current is soon applied and should constitute the basis of treatment. These muscles respond only to a very slow rate of stimulation (ten or twenty per minute). Even if there is no reaction of degeneration the faradic current should be used with care. If the muscles, although not in degeneration, respond only to a very slow rate of stimulation, and if their contraction is sluggish and worm-like, again it is the slow galvanic sinusoidal current that offers the most desirable form of stimulation. Only when a certain degree of response occurs should the faradic current be employed.

The individual method of stimulation is the method of choice in these cases. Application must be essentially progressive. At the first sitting, with a very low intensity, contractions are elicited. It is not necessary to have strong contractions. A flicker is sufficient. Periods of rest between contractions must be adequate. Later on, according to the improvement shown by the patient, stronger contractions are elicited, and the periods of rest may be shortened. At all events, even at that period, general ultra-violet irradiation for its general trophic effects, diathermy or galvanic current, and local infra-red irradiation for its trophic and circulatory effects, massage and exercise, should be used.

## FARADIC CURRENT IN FACIAL PARALYSIS

This is a special modification of the application of the faradic current in neuritis. The place of faradic current in facial paralysis can be understood from the general direction of physical treatment of this condition. Here we have a condition in which faradic current, if used at all, demands care, as ill-considered applications may result in complications and contraction.

The following are the steps in the electrical treatment of facial paralysis:

(1) During the first fortnight, infra-red irradiation, constant galvanic current and massage are used. The patient should be instructed to exercise the facial muscles in front of a mirror. The electrical reactions should be tested.

(2) The interrupted galvanic current is next used.

(3) In the terminal period of treatment, if the muscles respond to faradic current this should be employed very gently, with low intensity and long periods of rest between contractions. If, during this period, the muscles show reaction of degeneration the faradic current should not be used (it elicits no reaction) but the interrupted galvanic or other more complicated currents, such as the sinusoidal or Lapicque current, should be utilized.

## FARADIC CURRENT IN HABITUAL CONSTIPATION

In habitual constipation the first, and possibly the most important, method of treatment is correction of all the etiological factors which pertain to the mode of life -- diet, hygiene, social environment -- and which have determined the morbid condition. Great care should be given to diet, and in certain cases mild laxatives should be cautiously administered. On the whole, however, even mild laxatives can be avoided in early cases by adding physical therapy to general treatment. It is best to avoid laxatives -- although this avoidance must not be carried too far -- and to restore normal intestinal function by means of physical methods.

Of the physical methods the important ones are exercise, particularly of the abdominal muscles, massage of the abdominal muscles and, according to the degree of spasticity or atony of the colon, massage of that organ. The latter procedure is scarcely ever applied because it can be performed only by a physician who not only knows the anatomy of the colon, but who can also judge its degree of spasticity or atony and can follow up the patient from the clinical point of view.

The faradic current is an extremely valuable adjunct. The electrodes are placed at the front and back, the digestive organs being thus in the path of the current. It should be remembered, however, that the current applied by this means does not really pass through the viscera. Although faradic and low-voltage currents may travel through the abdomen, whatever current passes is so likely to seek out the fluids that are good conductors that we cannot obtain anywhere a density sufficient for direct stimulation of the intestinal muscles.

The mode of action of the faradic current in habitual constipation is its influence on the metabolism of the abdominal muscles and principally its stimulation of the skin of the abdomen and of the abdominal peripheral tissues in general. The latter action determines contraction of the colon musculature through a reflex route, and in such cases the reflexotherapeutic effects of faradic current are called into play.

A large moistened pad electrode (4" x 6") is placed over the abdomen, and another of equal size directly opposite on the back. The faradic current, usually surging, is passed in gradually increasing strength until definite contractions of the abdominal wall are evident. It is advisable to synchronize these contractions with the rate of respiration, producing about 18 to 20 contractions per minute. The current may be increased during successive treatments.

## FARADIC CURRENT IN POST-OPERATIVE WEAKNESS

Among the other applications of faradic current one of the most important is for post-operative weakness, for which Smart has given certain indications. Cases suitable for treatment are those of atonic abdominal muscles after child-birth, the treatment beginning within a week after the birth, unless contra-indicated for special reasons, and continued for 3 or 4 weeks. 30 minute sessions are given. The faradic current should be combined with massage of the abdominal muscles.

## FARADIC CURRENT IN PSYCHONEUROTIC CONDITIONS

The faradic current is a valuable adjunct to treatment of psychoneurotic conditions both for its reflexotherapeutic and its psychological effects. Weir Mitchell, in his famous treatment of neurasthenia by rest, applied at the same time massage and faradic stimulation so as to avoid the bad effects of lack of exercise. Today we speak much less of neurasthenia, and in fact all the so-called psychoneuroses have more or less been recognized as endocrine metabolic disturbances. It is the action of physical methods on the regulators of metabolism that renders them so valuable in the treatment of psychoneuroses, and, as we have seen, faradic current possesses a definite action in this respect, probably through stimulating the secretion of the adrenal gland. Recent work on the physiology and pathology of the adrenals has shown that many cases of so-called asthenia (neurasthenia) are due to a temporary and mild insufficiency of these important organs, and many authors have obtained powerful physiotherapeutic effects by stimulating the adrenal glands which produce the cortical hormone, thus obviating external substitution treatment.

## FARADIC CURRENT IN OBESITY

Bergonie introduced the faradic current into treatment of obesity. It is applied by means of a special apparatus for group muscular stimulation. The principle underlying the method is to make the muscles contract and thus metabolize the superfluous fat.

Since our conception of obesity, and thus of the principles governing treatment, has changed of recent years, the place of faradic current in the treatment of this condition has also undergone modification. Obesity is now considered a symptom, not a disease in itself, and we, therefore, speak of diseases with obesity. These diseases are endocrine metabolic disorders, frequently neuro-pituitary or bi-lobar pituitary conditions, and, in some cases, hypothyroidism or cortical hyper-adrenalism.

The change in conception no longer allows us to place faradic current treatment of obesity in the foreground, but allots it a certain position. Undoubtedly the Bergonie treatment, in certain cases, combined with other measures (active exercise, diet and endocrine therapy) gives excellent results. These, however, are no longer explained by the simple combustion of fat through muscle contraction, but by the powerful reflexotherapeutic effect of the faradic current on the endocrines and vegetative nervous system, disturbances in which cause obesity.

The faradic current has another important effect which permits us to maintain Bergonie treatment in obesity. In endocrine metabolic disorders we must consider not only the deficiency of one endocrine, but the inadequate reaction of the body cells to certain hormones. There are cases of obesity, for instance, in which the pituitary fat-metabolizing hormone, or thyroid hormone may be normal in output but

the body cells do not react and are not permeable to these hormones. Physical procedures are excellent for improving peripheral permeability, probably through action on the vegetative nervous system. Bergonie treatment does improve cellular reactivity to hormones, and thus can help endocrinotherapy. It is to be remembered that certain other procedures, such as hydrotherapy and mud-baths as used at Marienbad, have a similar effect in enhancing cellular permeability to hormones and thus of favouring endocrinotherapeutic action.

## CONTRA-INDICATIONS OF FARADIC CURRENT

Faradic current is useless and often dangerous in all lesions of the upper neuron. It is dangerous because it may increase the tendency to spasm, and thus is absolutely contraindicated in all cerebral hemiplegias.

On the whole faradic current should be used with care in every case in which the neuro-muscular system shows evidence of hyperexcitability or of undue depression. It may increase the hyperexcitability and determine spasm, and when muscles are exhausted it can determine fatigue of the metabolic functions and thus aggravate the condition. In such cases the faradic current, if used at all, should be applied in the minimal dosage. This dosage has been shown by Aubourg in France to have far-reaching effects, although appearing insignificant. Physical medicine as well as endocrinotherapy, has taught us to appreciate the minimal dosage.

## GENERAL CONCLUSIONS

The faradic current acts in three ways: First, it effects direct stimulation of muscular contraction, through direct stimulation of the motor nerves of the muscles. By this means it assists the local muscle metabolism. Secondly, it acts reflexly, principally on the regulators of body metabolism. Finally, it acts psychologically. In the therapeutic applications of the faradic current these three mechanisms act in combination.

Thus faradic current should not be considered a local method of treatment. Like all physical procedures, it is a general metabolic treatment, stimulating and regulating metabolism through action on the endocrines (particularly in the adrenals) influencing the vegetative nervous system and the psycho-associational cortex.

For this reason faradic current must be applied in the light of the general constitutional examination of the patient, and in conjunction with other procedures which produce similar effects.

The local metabolic action on the muscles is utilized mainly in treatment of muscle atrophy and paralysis following lesions of the joints and of the paralysis following certain neuritic conditions. The reflexotherapeutic action of the faradic current is manifest in obesity and various endocrine disturbances, the psychotherapeutic action in psychoneurotic conditions and in diseases of the nervous system in general.

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